

DIURNAL VARIATIONS OF THE ACHILLES REFLEX TIME IN NORMAL  
MAN

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16. Abstract  The Achilles tendon reflex time was recorded in the morning, at midday, and in the evening during five days in 18 normal sedentary subjects. Every recording measured the following intervals: SD (contraction time), DP (true half-relaxation time), SP (sum of SD and DP). These intervals were significantly longer in women than in men. Their variations from day to day were not very important. Contrasting with these, their diurnal variations were significant, and showed a lengthening from morning to evening, principally for DP and SP. These findings and their consequences in the clinical use of the Achilles tendon reflex time were discussed.			
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# DIURNAL VARIATIONS OF THE ACHILLES REFLEX TIME IN NORMAL MAN

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## Introduction

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Due to its simplicity, measurement of the Achilles tendon reflex time is currently a widespread complementary test in France in clinical study of thyroid diseases and metabolic disorders [2, 3, 4, 9, 18]. It also appears that this method of testing neuromuscular function can be used in athletic medicine to evaluate physical fitness or supervised training [6, 8, 11]. Now, to be of value this test must be reliable; in other words, the spontaneous variation over measured time intervals must be negligible in a subject whose physical condition does not vary.

Various investigators [1, 5, 15, 19] have noted the effects which physical activity, even moderate physical activity, can have on the reflex time intervals, significantly decreasing the contraction time SD. It now seems fairly definite that one of the main causes of error in interpretation /208 of the tracings lies in the fact that the patient is examined without undergoing sufficient rest beforehand.

Elsewhere, Zamrazil et al. [21], in tests on patients with thyrotoxicosis or hypothyroidism have observed a gradual lengthening of the SP interval (half-relaxation time) from morning to evening, while no significant diurnal variations were observed in subjects with normal thyroid function.

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\*Numbers in the margins indicate pagination in the foreign text.

We felt it would be interesting to determine the nature of the spontaneous variation in Achilles tendon reflex time intervals from one day to the next and from one period of the day to the next in a group of sedentary normal subjects (laboratory personnel).

### Methods and equipment

For five consecutive days, we examined 18 subjects in good health, nine men 21-39 years of age (average age: 26) and nine women 21-45 years of age (average age: 31). Each individual was tested three times a day without any physical stress: between 8 o'clock and 9 o'clock in the morning, between 11:30 and 1:30 at midday, and between 5 o'clock and 6 o'clock in the evening. This time distribution was chosen because of its convenience (beginning and end of work). It covered almost half anychthemer on, from 7 o'clock a.m. to 7 o'clock p.m.

The Achilles reflex time was attained by the Lawson magnetic method [10], using the Hellige assembly described in the thesis of Inquimbert [7]. The reflex was excited ten times in succession, once every two seconds. The temperature of the site tested was between 20 and 23°C. The recording speed was 5 cm/sec. The ten responses obtained made it possible to determine the reflex time intervals on a sufficient approximation. Each tracing, which represented the speed of the movement rather the movement itself, was used to measure the contraction time SD, the true half-relaxation time DP and the half-relaxation time SP (sum of the two preceding).

The results were subjected to variance analysis, using a complete block factorial design, without replication, with four sources of variation making it possible to reveal simple effects and interactions with sex, individuals, the different

days and the three periods of the day. The risk  $\alpha$  chosen corresponded to a probability  $P = 0.05$ .

## Results

The overall results of the variance analysis are given in Table 1. Table 2 gives the averages obtained by subject and by period of the day.

### a) "Subject" effect

The subject effect was highly significant for the three variables studied. Each reflex time interval varied greatly from one subject to the next. We have computed the confidence intervals of the averages obtained for the two groups, men and women (Fig. 1).

TABLE 1. VARIANCE ANALYSIS: SIGNIFICANCE OF F PER VARIABLE AND PER EFFECT STUDIED

Variables Effects and interactions	SD Inter- val	DP Inter- val	SP Inter- val
Sex .....	xxx	xxx	xxx
Subject .....	xxx	xxx	xxx
Day .....	NS	NS	NS
Period .....	x	xxx	xxx
Sex x subject.....	xxx	xxx	xxx
Sex x day.....	NS	NS	NS
Sex x period.....	NS	NS	NS
Subject x day.....	x	x	xxx
Subject x period.....	NS	NS	NS
Day x period.....	NS	NS	NS

N.B.: XXX: F significant for  $P = 0.001$ .

XX: F significant for  $P = 0.01$ .

X: F significant for  $P = 0.05$ .

NS: F not significant for  $P \leq 0.05$ .

b) "Sex" effect

The "sex" effect was highly significant (Fig. 1): all the time intervals were longer in women than in men. This difference was an average of 5 msec for SD, 21 msec for DP, and as a result, 26 msec for SP. In addition, for each variable there was a highly significant interaction between the "sex" effect and the "subject" effect, although this interaction was of no special interest.

c) "Day" effect

The "day" effect was not significant for any of the variables. In the groups studied, therefore, there were no significant fluctuations in the reflex time intervals between days. The interaction between the "subject" and "day" effects, which was significant for the three variables, emphasizes the fact that the "subject" effect was not identical from one day to the next.

d) "Period" effect

The "period" effect was significant for SD and highly significant for DP and SP (Fig. 2): the three intervals increased from morning to evening. This phenomenon, which was discrete for SD (plus 2 msec on the average), was much more marked for DP (an average of +12 msec) and consequently for SP (average of +14 msec). The "period" effect did not interact significantly with any other effect. It was found equally in both sexes, in most of the subjects and on almost every day.

Discussion

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a) The "subject" effect does not call for any special observations. We know that with a given recording technique

TABLE 2. DIURNAL VARIATIONS IN REFLEX TIME INTERVALS.  
AVERAGE IN MILLISECONDS BY SUBJECT AND BY PERIOD.

Sub- jects.*	Age	SD interval			DP interval			SP interval		
		Morn- ing	Mid- day	Even- ing	Morn- ing	Mid- day	Even- ing	Morn- ing	Mid- day	Even- ing
1	25	194	194	193	123	115	150	309	318	349
2	22	159	160	150	79	86	95	246	237	254
3	41	189	189	190	140	137	137	326	329	326
4	28	172	177	171	85	92	74	263	256	245
5	28	201	204	209	174	181	195	385	376	405
6	30	201	207	211	161	182	174	389	362	385
7	21	167	164	167	81	77	82	242	248	249
8	39	185	182	179	112	112	110	293	297	289
9	45	192	196	192	145	141	142	337	337	334
10	25	176	175	176	72	73	76	248	248	252
11	25	179	182	177	90	93	98	275	268	273
12	24	191	189	200	91	92	101	281	282	301
13	21	188	190	194	96	105	113	295	284	307
14	25	178	182	177	78	94	86	276	256	263
15	26	181	184	192	92	104	81	288	273	273
16	39	175	177	178	88	102	124	279	264	302
17	25	182	178	181	134	165	162	343	317	343
18	21	167	166	165	116	133	140	299	283	305

Subjects 1-9: women

Subjects 10-18: men

the reflex time intervals are considered normal when they are located within a fairly wide band. With the Hellige assembly, normal SD and SP intervals are considered to fall between 150 and 200 msec and between 240 and 300 msec, respectively [7]. The values obtained here conform to these standards in most cases. Their dispersion among the individuals confirms this fact: each subject (or each group of subjects) can be compared only to himself (or itself) when several reflex time tests are performed in immediate succession. Thus the results obtained from different subjects (or different groups of subjects) cannot be compared. These results may show significant differences without the existence of any differences in the physical condition of the individuals involved.

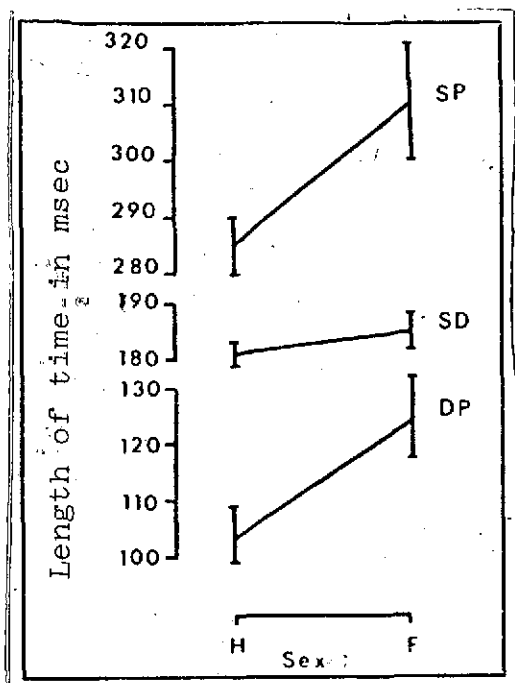


Fig. 1. "Sex" effect. Each average is given with its confidence interval at 5%.

b) The "sex" effect has already been observed by several investigators [13, 15, 20], who have found a lengthening of SP in women over that observed in men. The results reported here seem to indicate that this phenomenon also affects SD and DP at the same time. Since reflex time intervals are known to lengthen with age [2, 13, 15, 20], it may be objected that the average age of our female subjects was higher than that of the male subjects, and thus the effect attributed to sex would actually depend on the age difference. In reality, the age difference here seems to be too slight to explain such a significant effect, and it does seem that the results obtained should be attributed to sex rather than age. Finally, our experiments did not allow for the hormonal condition of the female subject. We know that pregnancy has an appreciable effect on reflex time, provoking a lengthening of interval [12]. On the other hand, it may be assumed that monthly cyclic variations

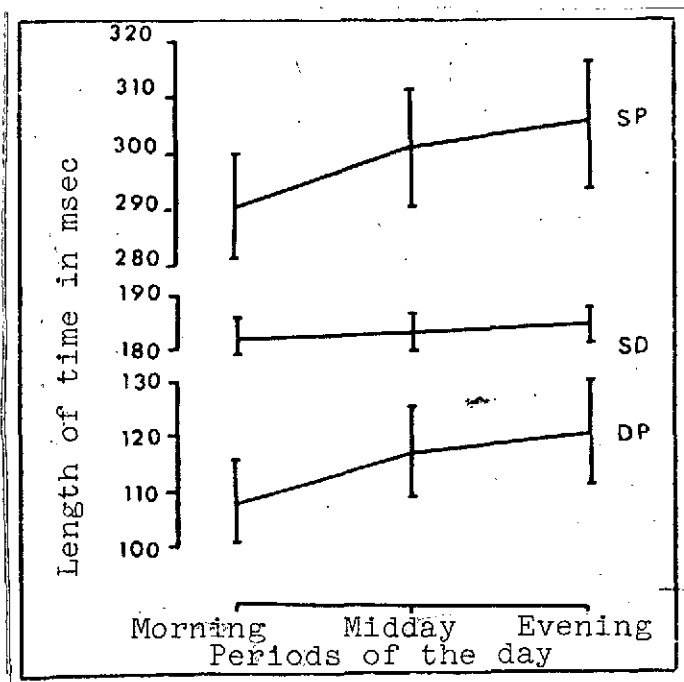


Fig. 2. "Period" effect. Each average is given with its confidence interval at 5%.

in women and the taking of oral contraceptives have no appreciable effect on the SD interval.

c) The "day" effect was not significant in our observations. The absence of appreciable day-to-day variations in the overall results does not exclude the possibility of intra-individual variations from one day to the next, but it does point toward a comparison of tracings obtained on different days from a given group of subjects. A comparison of this sort could be valuable in the supervision of patients being treated for thyroid disease.

d) The "period"<sup>42</sup> effect has already been studied by Zamrazil et al. [21]. Our results did not agree with those obtained by these investigators, who observed a "period" effect in subjects with thyroid disease, while normal subjects showed no significant diurnal variations in SP. This discrepancy may be the result of different experimental conditions. Our research dealt with 18 healthy subjects tested over five consecutive days of normal sedentary work, while the above investigators examined only ten hospitalized patients with normal endocrine balance, tested five times over a single time lapse of 24 hours. It is therefore possible that the schedule followed by Zamrazil et al. was not extensive enough to reveal a "period" effect in normal individuals. Thus there does not seem to be any theoretical contradictions between our results and those obtained by these investigators.

It is difficult to explain the lengthening of reflex time intervals during a day of sedentary work. Since we were unable to use a constant tapping force, we were unable to determine whether the amplitude of the reflex movement fluctuated from morning to evening. Nevertheless we do know that the lengthening of time intervals cannot be attributed to a change

in the amplitude of the movement, since the temporal component of the reflex (time interval) is independent of its spatial component (number of motor units determining the amplitude of the contraction) [2, 7].

1) Contraction time. Implied in SD and SP, this was determined by the degree of synchronization of the motor units, as well as by the contractile properties of the muscular fibers of which they were composed. We do not know whether the motor discharges of the tendon reflex are less well synchronized in the evening than in the morning. It seems improbable that desynchronization would occur from morning to evening. Assuming that fatigue would gradually increase during the day, this fatigue could affect the voluntary or reflex motor activity by further synchronizing the motor units engaged in a given muscular contraction. This is the type of phenomenon which provokes trembling due to fatigue [16]. Increased synchronization in the reflex discharges would thus shorten SD. This may be what happened with some subjects in whom SD decreased from morning to evening (Table 2). In other individuals, the lengthening of SD was probably related to changes in the contractile properties of the muscle fibers which were influenced by the ionic composition of the circulating blood and by the levels of certain hormones in the blood, since agents exerting thyroid hormone activity are believed to inhibit the ATPase activity of actomyosin and shorten the contraction time of the muscle. This would explain the shortening of the SD and SP in hyperthyroid subjects [9]. The diurnal variations of SD and SP in healthy subjects would thus depend on circadian /211 fluctuations in thyroid activity. However, the average diurnal variation of SD, which is not very great, seems to be negligible in the clinical use of reflex time measurements: the error is close to the error observed in measurement of this interval on a tracing.

ii) The true half-relaxation time DP, on the other hand, undergoes a much sharper lengthening from morning to evening (Table 2). This phenomenon also affects the SP, the interval widely used in clinical practice. We ourselves have observed [11] a lengthening of DP in healthy, physically untrained subjects having performed short-term muscular exercise on an ergometric bicycle. According to Petajan and Eagan [14], it would appear that the increase in the length of the relaxation time is related to less satisfactory trophicity of the fatigued muscles. According to these investigators, the cramps and myotonia of fatigue are manifestations of the same phenomenon. A similar mechanism may be responsible for the diurnal variations of the DP: the gradual onset of some degree of fatigue in sedentary individuals during the day would thus produce a lengthening of the relaxation time. On a practical level, the diurnal variations of DP and SP could thus be a cause of error in clinical interpretation of the Achilles tendon reflex time.

In conclusion, it does seem that diurnal variations of the Achilles tendon reflex time can give rise to error in the interpretation of successive tests if these tests are not performed at a given hour of the day and after a preliminary period of rest. Although the error in the contraction time (SD) appeared negligible, this was not the case with the half-relaxation time (SP), which lengthened considerably from morning to evening in most of the subjects. Given this uncertainty, measurement of the SD interval thus seems to be more reliable than measurement of the SP interval.

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